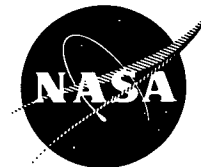


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Design Criteria Monograph on Turbopump Systems

A design criteria monograph has been published which is a summary and a systematic ordering of the large and loosely organized body of existing successful design techniques and practices for the design of liquid rocket turbopump systems.

This monograph was written to organize and present, for effective use in design, the significant experience and knowledge accumulated by NASA in development and operational programs. It reviews and assesses current design practices, and from them establishes firm guidance for achieving greater consistency in design, increased reliability in the end product, and greater efficiency in the design effort.

The turbopump assembly for a modern liquid propellant rocket engine is a complete system in itself. It consists of many components, some of which are themselves subsystems (e.g., the pump and the turbine). This monograph deals with the turbopump as a system, covering selection of the proper system type for each application and integration of the components into a working system.

Rocket engine turbopumps have demonstrated excellent reliability in service. However, because of the strong emphasis on light weight and high performance, many of the turbopump components are designed near the limits of the state of the art. Therefore, many problem areas must be avoided if the turbopump is to be reliable and compatible with the vehicle. For example, to meet the performance and weight requirements, the turbopump must operate at high speed, and, consequently, must have bearings and seals that will satisfy life requirements at high speed; in addition, the pump must have a high-suction-performance inducer so that tank pressure and weight are minimized. At the same time, the turbopump housing must accommodate the wide variations in temperature between the pump and the turbine without affecting alignment or imposing excessive radial or axial loads on the bearings. The design problem is made more complex by the wide range of possible duty cycles and by a constantly advancing state of the art.

The monograph is organized to follow the logical succession of events in the development of a turbopump system from preliminary design through testing on the rocket engine. This process normally begins with a preliminary design phase in which the turbopump size, the component types, and the component arrangement are selected to meet the system requirements. The next phase is detail design and integration, in which the final rotational speeds are selected within the constraints of the various mechanical and hydrodynamic limits, the pump and the turbine are optimized within the constraints of the mechanical and fluid dynamic limits, and the components are integrated into an overall turbopump assembly. The final phase is design evaluation, in which the turbopump design is evaluated by both computer simulation and experimental testing.

The monograph comprises two major sections: State of the Art, and Design Criteria and Recommended Practices. References complement the text.

The State of the Art section reviews and discusses the total design problem and identifies the design elements that are involved in successful design. The Design Criteria state clearly and briefly each rule, guide, limitation, or standard that must be imposed on each essential design element to assure successful design; the Recommended Practices set forth the best available procedures for satisfying the Design Criteria.

Both major sections are divided into three subject categories: Preliminary Design (system requirements, system selection); Detail Design and Integration (rotational speed, pump and turbine design, mechanical integration, interfaces, start systems); and Design Evaluation (system characteristics, dynamic analysis, testing).

This thorough review of design criteria and practices relating to turbopump systems should be of interest to users, designers, and manufacturers of pumps, turbine drives, and turbomachinery in general.

(continued overleaf)

Notes:

1. This monograph has been published as the following report:

NASA SP-8107 (N75-20470), Turbopump Systems
for Liquid Rocket Engines

- Copies may be obtained at cost from:

Aerospace Research Applications Center
Indiana University
400 East Seventh Street
Bloomington, Indiana 47401
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2. Specific technical questions may be directed to:

Technology Utilization Officer
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